Assessment of mitochondrial membrane potential using an on-chip microelectrode in a microfluidic device.

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Public Summary:

Scientific Abstract:
The mitochondrial membrane potential is used to generate and regulate energy in living systems, driving the conversion of ADP to ATP, regulating ion homeostasis, and controlling apoptosis, all central to human health and disease. Therefore, there is a need for tools to study its regulation in a controlled environment for potential clinical and scientific applications. For this aim, an on-chip tetraphenylphosphonium (TPP(+)) selective microelectrode sensor was constructed in a microfluidic environment. The concentration of isolated mitochondria (Heb7A) used in a membrane potential measurement was 0.3 ng microL(-1), four orders of magnitude smaller than the concentration used in conventional assays (3 microg microL(-1)). In addition, the volume of the chamber (85 microL) is 2 orders of magnitude smaller than traditional experiments. As a demonstration, changes in the membrane potential are clearly measured in response to a barrage of well-known substrates and inhibitors of the electron transport chain. This general approach, which to date has not been demonstrated for study of mitochondrial function and bio-energetics in generally, can be instrumental in advancing the field of mitochondrial research and clinical applications by allowing high throughput studies of the regulation, dynamics, and statistical properties of the mitochondrial membrane potential in response to inhibitors and inducers of apoptosis in a controlled (microfluidic) chemical environment.